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Upper Yukon Drainage Fall Chum Salmon Studies

1974

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Lance Trasky

Alaska Department of Fish and Game
Division of Commercial Fisheries
Anchorage, Alaska

UPPER YUKON DRAINAGE FALL CHUM STUDIES

Introduction

Fall chum salmon are unique stocks of chum salmon which are distinguished from summer chum by: (1) later river entry and spawning dates; (2) utilization of upriver spawning areas and (3) larger size. All of the known fall chum spawning areas in the Yukon drainage are located upstream of the mouth of the Tanana River (Figure 3). In most instances fall spawning areas are believed to be affected by upwelling ground water, generally maintaining winter water temperatures above 34° F.

In 1974 over 305,000 fall chums were taken in the Yukon drainage by commercial and subsistence fishermen. Although fall chums have comprised an increasingly important portion of the total Yukon River salmon catch, very little information regarding their life history, abundance, and distribution was available before 1972. In 1972 and 1973 several important spawning areas were located in which the numbers of spawning fall chums were estimated. An intensive study was begun in 1973 on the Delta River fall chum population which provided information on life history and physical characteristics of the spawning area. In 1974 aerial survey coverage was extended to all known and suspected spawning areas and the Delta River studies were continued. The objectives of the 1974 studies were:

(1) Determine the distribution, abundance, and timing of fall chum salmon populations in the upper Yukon drainage.

(2) Compare various methods of estimating the size of the Delta River fall chum salmon spawning population.

(3) Determine the stream residence (life span) of tagged chum salmon in the Delta River.

(4) Determine the age, sex and size composition of the Delta, Tanana, Sheenjek, and Toklat River fall chum populations.

(5) Determine if there is a difference in timing of post-spawning dieoff between male and female fall chums.

The Delta River drains the Alaska Range and empties into the Tanana River just downstream from the Richardson Highway bridge. The Delta River during the summer is a typical glacial stream with silt-laden water and braided channels. During freeze-up, the surface waters gradually diminish, eventually

cease, and ground water seepage forms the spawning area under study which is located in the lower mile of the floodplain (Figure 12). During the last 2 years, spawning occurred in three major channels which consist of a series of large, clear shallow pools separated by riffles during October to early May. These characteristics make it very easy to capture and observe spawning salmon. The shallow riffles keep dead and dying salmon from drifting out of the study area.

Methods and Materials

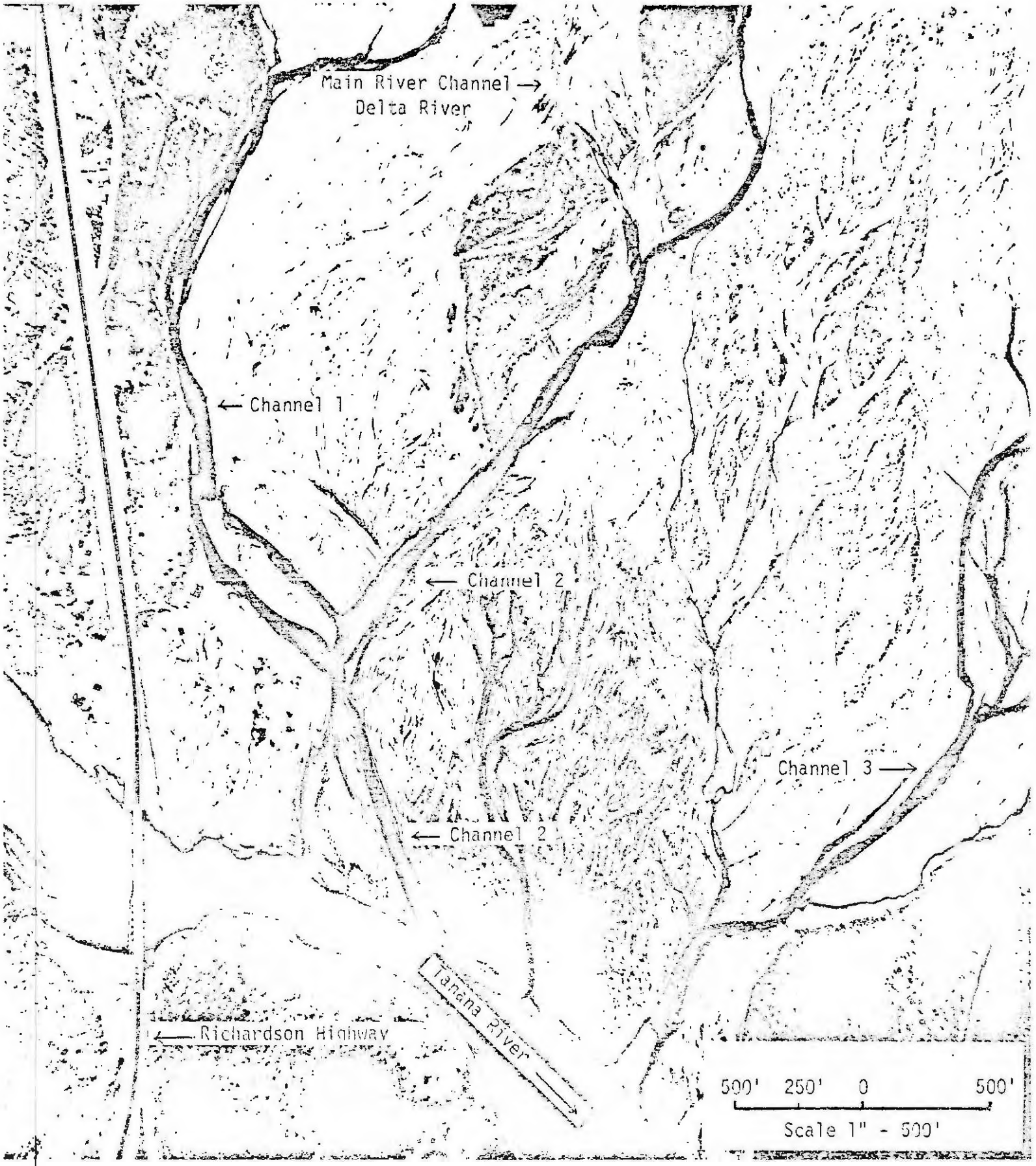
Fall chum salmon were captured approximately 200 feet inside the mouth of the Delta River with a 150 foot x 4 foot x 2 inch mesh beach seine. The fish were held in the seine while the length from mid-eye to fork of tail was measured, sex determined, and tags applied. Only silvery, healthy fish which were just entering the river were tagged. Each salmon was tagged with a numbered red Peterson disc tag in the muscular portion of the back, anterior to the insertion of the dorsal fin. A scale smear was taken from each of the tagged fish for use in the later determination of the age composition of the spawning population. Tagged salmon were held for a few minutes after tagging to insure they had not been injured before release. No tag rewards were paid for these fish.

Tag recoveries were made during a daily intensive carcass survey of the three channels comprising the Delta River spawning grounds. A record of the total number of carcasses by sex and location of recovery was kept each day. A log of all tag recoveries was kept by tag number, date, and location of recovery. A portion of the carcasses was sampled for age, sex, and size composition. Spawning success was gauged by examining the gonads of carcasses. To avoid resampling, all carcasses were removed from the water and thrown up on the bank.

A sample of unspawned female chums was killed, weighed, a scale smear taken, and the length from mid-eye to fork of tail determined. The ovaries were removed and preserved in a 30 percent formaldehyde solution for laboratory examination at a later date. Fecundity was determined volumetrically.

On October 29 and 31, near the peak of spawning, two aerial survey estimates were made of the Delta River spawning population. A helicourier STOL aircraft was used with a different observer for each survey. Two biologists made estimates of the spawning population on foot surveys of the Delta spawning area on November 1. On November 1 aerial photographs of the entire spawning area were taken with a Kargl camera with a 12-inch focal length. The camera was mounted in a Cessna 180 aircraft which was flown at 80 mph and an altitude of 600 feet. Kodiak double x estar base film was used. A series of

Figure 12. Delta River fall chum salmon spawning area, November 1, 1974.



negatives, with a 10 percent end lap and a 9 inch x 9 inch frame size, were produced for each spawning channel. The scale for the negatives was 1 inch equaling 50 feet. The negatives were placed on a light table and examined for the presence of salmon. Counts were made of the number of chums in each spawning channel.

During tag and recovery operations on the Delta River, water temperatures and climatological data were recorded daily and limnological data periodically. Ryan thermographs were used to obtain continuous temperature records in all three channels of the Delta River during the study period.

Aerial surveys were made of other known and suspected fall chum spawning areas in the Alaskan portion of the Upper Yukon drainage. A helio-courier aircraft was used to fly most surveys. A helicopter was used to fly a survey of the Tanana River in the area of the Trans-Alaska pipeline crossing. Additional escapement information was received from the Sport Fish Division of the Alaska Department of Fish and Game and the Environment-Canada Fisheries Service. Carcass samples were also taken from fall chum salmon spawning areas on the Tanana, Toklat, and Sheenjek rivers to provide comparative data on age, sex, and size composition.

Results

Fall chum salmon began entering the Delta River on October 8 and small numbers of live fish were still present on November 17 when the study was terminated.

A total of 403 fall chums was tagged between October 11 and 28 (Appendix Table 15). A total of 2,256 carcasses was recovered from the spawning channels and examined for tags (Appendix Table 16). A total of 151 tags was recovered from carcasses by the survey crew (Table 16). In addition, eight tags were either recovered from fishermen or were found loose in the spawning area (tag loss, fish killed by predators). These tags and fish were not included in the stream life estimates but were utilized in the population estimate.

Of the 403 chums tagged, 65 were tagged in channel 1, 274 in channel 2, and 64 in channel 3. A substantial portion of the chums tagged were not recovered as carcasses in the channel where they were tagged. Recoveries made in the other two channels were 17, 6 and 33 percent for fish tagged in channels 1, 2 and 3 respectively (Table 16).

Based on daily tag recoveries from carcasses, the average stream life was 19, 17, and 19 days respectively for channels 1, 2, and 3. The average

Table 16. Fall chum salmon tagged and recovered in each Delta River channel, 1974.

Tags applied		Recoveries 1/							
		Channel 1		Channel 2		Channel 3		Total recovered	
	No.	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Channel 1	65	24	83.0	5	17.0	-	-	29	100.0
Channel 2	274	6	6.0	95	94.0	-	-	101	100.0
Channel 3	64	3	14.0	4	19.0	14	67.0	21	100.0
Totals	403	33	22.0	104	69.0	14	9.0	151	100.0

1/ Does not include 3 predator-killed chums, 1 broken tag, and 4 tags turned in by fishermen.

stream life for all three channels was 18 days. Male chums had an average stream life of 15 days and females 21 days in 1974 (Table 17).

The seven hundred sixty chums from the combined Delta River channels were examined for age, sex and size. Age classes 3_1 to 5_1 were represented with age class 3_1 comprising 54 percent of the sample (Table 18). Male chum composed 63 percent of the above sample. Male chums composed 51 percent of the 2,256 carcasses examined for sex only (Appendix Table 16). The average length was 580 mm for males and 570 mm for females.

Based on gonad examinations of 496 carcasses, 96 percent of the male and 95 percent of the female chums were partially or completely spent (Table 19). An average of 139 eggs was retained per female. Male carcasses predominated in the daily carcass surveys from October 13-November 18 and females from November 9-17 (Figure 13).

The fecundity sample was composed of 18 female chums with an average weight of 2.2 kg and an average length of 560 mm. Age classes 3_1 and 4_1 were represented with age class 3_1 fish composing 72 percent of the sample. The mean fecundity was 1,886 eggs per female (Table 20).

Various estimates of the spawning population magnitude are presented in Table 21. A Peterson population estimate of 5,718 was obtained. Peak counts resulting from aerial surveys, foot surveys and examination of aerial photographs ranged from 1,906 (foot survey) to 4,010 (aerial survey). A total of 2,256 carcasses were collected through November 17.

Climatological and limnological data for the Delta River is presented in Appendix Tables 17 and 18.

The age, sex and size composition of the Delta River tagging sample and the Delta, Tanana, Toklat and Sheenjek River carcass samples is presented in Appendix Table 19.

The results of all the aerial surveys of the upper Yukon drainage are presented in Appendix Table 20. Large spawning concentrations of fall chums were located in the Sheenjek and Chandalar rivers.

Discussion

In 1973 and 1974 chum salmon entered channel 2 approximately 10-13 days later than the other two channels. This delay was apparently due to the colder surface water runoff still present in this channel in early October (Trasky, 1973).

Table 17. Stream life by channel, Delta River, 1974.

Stream life	Channel 1			Channel 2			Channel 3			Combined		
days 1/	males	females	comb.	males	females	comb.	males	females	comb.	males	females	comb.
2	-	-	-	1	-	1	1	1	2	2	1	3
3	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	2	-	2	-	-	-	2	-	2
5	1	1	2	-	-	-	-	-	-	1	1	2
6	-	-	-	1	-	1	-	-	-	1	-	1
7	-	-	-	-	1	1	-	-	-	-	1	1
8	-	-	-	1	-	1	1	-	1	2	-	2
9	-	-	-	-	-	-	-	-	-	-	-	-
10	1	-	1	4	-	4	1	1	2	6	1	7
11	-	-	-	8	2	10	-	-	-	8	2	10
12	-	-	-	6	-	6	1	-	1	7	-	7
13	-	2	2	6	2	8	1	-	1	7	4	11
14	-	-	-	2	1	3	-	-	-	2	1	3
15	1	-	1	7	3	10	-	-	-	8	3	11
16	1	-	1	5	3	8	-	-	-	6	3	9
17	3	1	4	4	4	8	1	-	1	8	5	13
18	3	-	3	6	8	14	-	-	-	9	8	17
19	-	1	1	4	5	9	1	1	2	5	7	12
20	2	1	3	3	3	6	-	-	-	5	4	9
21	-	2	2	3	2	5	-	1	1	3	5	8
22	-	3	3	2	-	2	2	-	2	4	3	7
23	-	1	1	1	-	1	-	1	1	1	2	3
24	-	1	1	-	-	-	-	1	1	-	2	2
25	-	-	-	-	-	-	-	-	-	-	-	-
26	1	3	4	1	-	1	-	1	1	2	4	6
27	-	-	-	-	-	-	1	-	1	1	-	1
28	-	-	-	-	-	-	-	1	1	-	1	1
29	-	-	-	-	-	-	-	1	1	-	1	1
30	-	-	-	-	-	-	-	1	1	-	1	1
31	-	-	-	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-	1	1	-	1	1
34	-	-	-	-	-	-	-	-	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-
36	-	-	-	-	-	-	-	-	-	-	-	-
37	-	-	-	-	-	-	-	-	-	-	-	-
Total Number 2/	13	16	29	67	34	101	10	11	21	90	61	151
Average Stream life days	17	20	19	15	21	17	15	22	19	15	21	18

1/ stream life between date of tagging and date of recovery on carcass survey

2/ does not include 3 predator-killed chums, 1 broken tag, and 4 tags turned in by fishermen

Table 18. Age, sex and size composition of fall chum salmon, combined carcass tagging sample, Delta River, 1974.

	Age Class			
	3_1	4_1	5_1	Total
Males				
Number	277	189	11	477
Percent	37.0	25.0	1.0	63.0
Mean length (mm) 1/	560	600	630	580
Females				
Number	131	146	6	283
Percent	17.0	19.0	1.0	37.0
Mean length (mm)	560	590	610	570
Combined				
Number	408	335	17	760
Percent	54.0	44.0	2.0	100.0
Mean length (mm)	560	600	620	580

1/ All lengths mid-eye to fork of tail.

Table 19. Post-spawning condition of fall chum salmon carcasses, Delta River, 1974.

	Spawned out	Partially spent	Did not spawn	Total	Average no. of eggs retained per female
Males	197 (62%)	107 (34%)	13 (4%)	317 (100%)	-
Females	151 (84%)	19 (11%)	9 (5%)	179 (100%)	139
Totals	348 (70%)	126 (25%)	22 (5%)	496 (100%)	-

Figure 13. Comparative sex composition of fall chum salmon carcass sample, by 3-day period, Delta River, 1974.

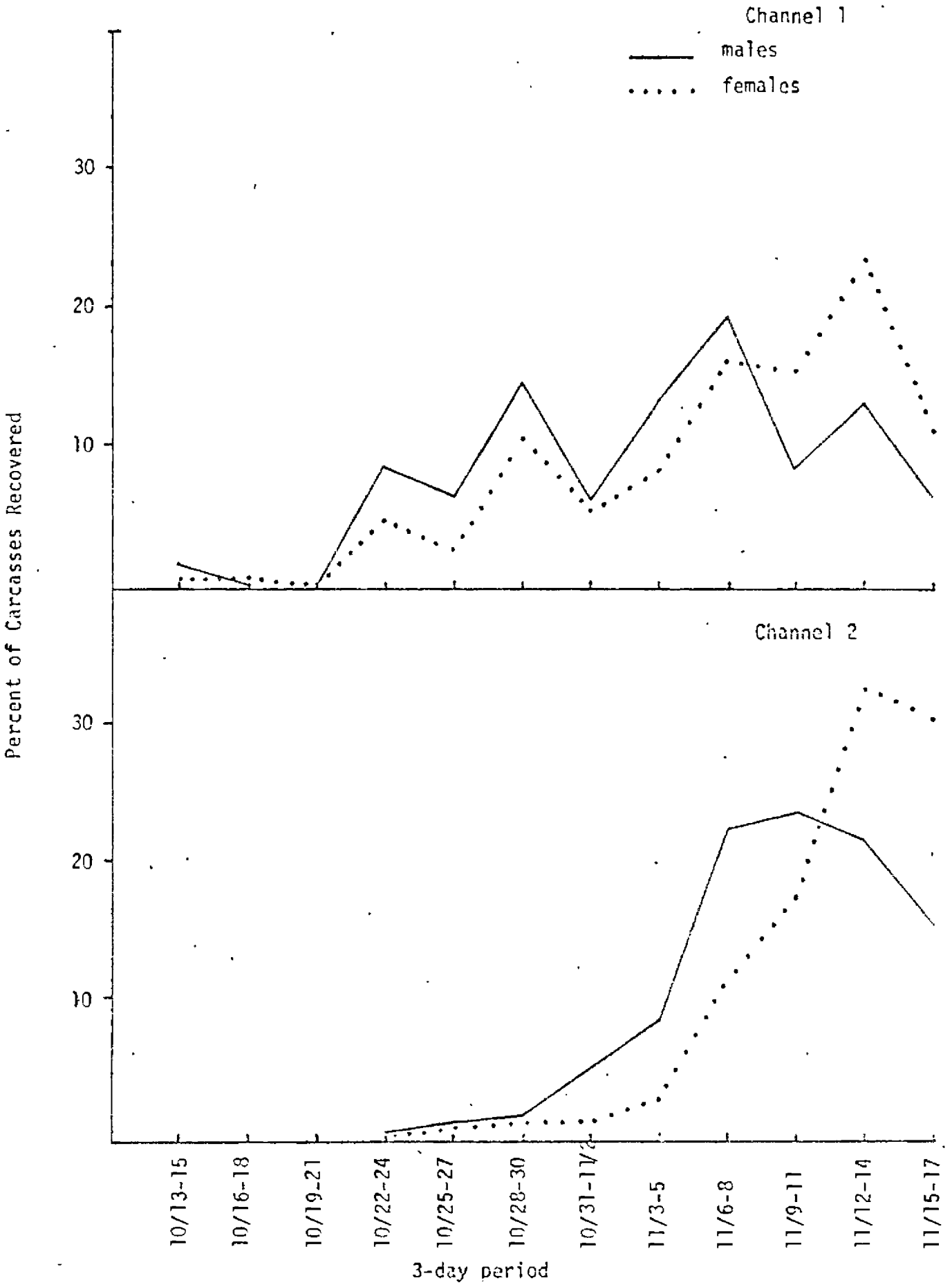


Table 20. Age, size and fecundity of Delta River fall chum salmon samples, 1974.

Sample no.	Age class	Length (mm)	Weight (Kg)	Fecundity (No. of eggs)
1	4_1	580	-	1,348
2	4_1	570	-	1,724
3	3_1	540	-	1,986
4	3_1	570	2.2	2,350
5	3_1	520	2.2	2,178
6	4_1	585	2.4	1,960
7	3_1	555	2.2	1,407
8	4_1	610	2.7	2,350
9	3_1	550	1.8	1,557
10	4_1	630	2.8	1,686
11	3_1	565	2.0	1,623
12	3_1	545	2.2	2,187
13	3_1	585	2.3	2,220
14	3_1	500	1.6	1,830
15	3_1	540	1.9	1,751
16	3_1	565	2.4	2,178
17	3_1	560	2.3	1,339
18	3_1	550	2.2	2,275
Average		560	2.2	1,886

Table 21. Comparative population estimates, Delta River, 1974.

Method		Date	Survey rating	Number of Fall Chums			
				Channel 1	Channel 2	Channel 3	Total
Aerial Photography		11/1	-	397	1,800	164	2,361
Aerial Surveys	(1)	10/29	fair	545	2,550	122	3,217
	(2)	10/31	fair	-	-	215	4,010
Foot Surveys	(1)	11/1	-	389	1,455	91	1,935
	(2)	11/1	-	450	1,235	221	1,906
Carcass Survey		11/17	-	595	1,590	71	2,256
Peterson Population Estimate		-	-	-	-	-	5,718

In 1973 and 1974 substantial numbers of salmon emigrated from the channel in which they were tagged into one of the other two channels. In both years channel 3, which was the smallest, had the greatest emigration and channel 2, which was the largest, the least. In addition to the fish that migrated between channels, several tagged salmon were observed during both years in a Tanana River spawning area 1/4 mile upstream from the mouth of the Delta River. The reasons for the observed emigration are not known but could be attributed to either tagging shock or normal homing behavior. Overcrowding can probably be eliminated as a factor in 1974 because of the relatively small number of spawners present in channels 1 and 3 which exhibited the greatest emigration.

Average stream life for tagged fish was 20 days in 1973 and 18 days in 1974. The average stream life of fish tagged in channel 2 was less than that for fish tagged in the other channels, probably due to the aforementioned delay in river entry. Males exhibited shorter stream lives than females by 1 and 5 days for 1973 and 1974 respectively. Female sockeye salmon have also been found to have longer stream lives than males (Foerster, 1968).

The several survey methods employed in 1974 produced widely varying estimates of population size. The accuracy of aerial survey counts is greatly influenced by the observer's ability to enumerate large numbers of both schooled and spawning fish in small areas during a short period of time. Foot survey accuracy is influenced by difficulties in counting milling fish in the wider and deeper portions of the channels (e.g. lower channel 2). The poor quality of some of the aerial photographs reduced the efficiency of this method. The peak aerial survey count of 4,010 made October 31 was substantially greater than the 2,361 count made from examination of aerial photographs taken November 1. The peak foot survey count made November 1 was 1,935.

These survey methods yield minimum estimates of the total spawning population since later arriving fish are not counted and spawned out carcasses, even if counted, are removed by predators at unknown rates. The Peterson tag-recovery estimate of 5,718 was substantially greater than any of the survey counts. However, this estimate was considered too high due to the emigration of an unknown number of tagged fish out of the study area.

Since carcass counts were made daily, the cumulative count should give a reasonably accurate estimate of the total spawning population. A total of 2,256 carcasses was counted through November 17. An estimated total of 600 live fish was present November 17 which accounts for a total of 2,856 fish. This number does not include possible removal of unknown numbers of fish and carcasses by predators and fishermen.

For purposes of this report and for use in subsequent spawning escapement comparisons, the 1974 Delta River spawning population is considered to be 3,300 fish. This figure is approximately midway between the range of all counts and is similar to the cumulative carcass and live fish count of November 17.

The 1974 Delta River carcass sample was dominated by the 3_1 age group which comprised 54 percent of the sample. The 1973 sample was comprised of 74 percent 4_1 age class chums. The 3_1 age group ranged from 45 to 73 percent fall chum samples from other locations in 1974 (Appendix Table 19). Reasons for changes in year class dominance between years is not known but may be related to faster growth and earlier maturity or unusually good brood year survival.

In 1973 and 1974 the Delta River escapement sample were composed of a greater percentage of 3_1 age class fish than either the Anvik or Salcha River summer chum samples. In 1973 and 1974 fall chums were larger than summer chums in the same age class with the exception of the 1973 summer chum 3_1 age class which were slightly larger than 3_1 fall chums for that year. In general, 1974 fall chums were as large as summer chums in the next older year class. Data from Japanese studies indicates that Asian fall chums were composed of a greater percentage of 3_1 age class fish than summer chums (Bakkala, 1971). Larger size is a characteristics used to distinguish fall chums from summer chums. Fall chums enter the Yukon River at least a month after the summer chums. Additional ocean growth coupled with genetic factors would account for the increase in size.

Male fall chum salmon dominated the early carcass samples whereas females dominated the later samples taken in the Delta River. This would indicate that it may be necessary to sample over the entire post-spawning dieoff to obtain an unbiased estimate of the sex composition of a spawning population. The same differential dieoff between male and female summer chums, was also observed in the Anvik River and Salcha River in 1974. The difference in post-spawning dieoff may account for the differences in sex composition between the Sheenjek and Toklat samples. The Sheenjek and Toklat samples were taken during a single day.

The average fecundity of the 1974 sample (1,886 eggs per female), was substantially less than the average fecundity (2,634 eggs per female) found in 1973 (Trasky, 1973). The 1974 females were smaller (560 mm) and weighed less (2.2 kg) than the 1973 females which averaged 589 mm in length and 2.9 kg in weight. Fecundity in chums has been found to increase with length and weight hence the smaller size of the 1974 fish could account for the decrease in fecundity (Bakkala, 1971).

In 1974 two major fall chum spawning areas were located in the Sheenjek and Chandalar rivers by aerial surveys. Smaller spawning areas were also located in the McKinley River, Nenana River, Salmon Fork of the Black River, Salmon Trout River, and Kevinjek Creek (Appendix Table 1). Escapement levels for 1974 in index streams were two to five times higher than 1973 levels in the lower Tanana drainage and slightly below 1973 levels in the upper Tanana (Appendix Table 20). All known fall chum spawning areas in the upper Yukon are shown in Figure 14.

Other potential fall chum spawning areas which should be investigated include the upper Tanana above the Gerstle River, the upper White River, the main Yukon above Fort Yukon, the upper Kantishna, the Koyukuk River drainage and the Anvik River.

The peak of spawning by drainage was essentially the same in 1973 and 1974. In the Porcupine and Chandalar River drainages the peak of spawning occurred during mid-September, in the lower Tanana, except for Moose Creek, the first week in October, and the upper Tanana and Moose Creek, the last of October.

Limnological and water temperature data from the Delta River exhibited essentially the same patterns in 1973 and 1974. Observations made during carcass surveys on the Tanana, Sheenjek and Toklat rivers indicated that these areas were also fed by upwelling spring water and are similar to the Delta River spawning area.